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Maracas et al.

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[54] METHODS AND SYSTEMS FOR BIOLOGICAL REAGENT PLACEMENT

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[ \* ] Notice: This patent is subject to a terminal disclaimer.

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[22] Filed: Oct. 16, 1997

Related U.S. Application Data

[63] Continuation of application No. 08/648,635, May 13, 1996, Pat. No. 5,731,152.

[51] Int. Cl.<sup>7</sup> C12Q 1/68; C12P 19/34; C07H 17/00

[52] U.S. Cl. 435/6; 435/91.1; 435/287.2; 101/327; 422/506; 536/23.1; 536/24.3

[58] Field of Search 435/6, 91.1, 287.2; 101/327; 422/131; 436/506; 536/23.1, 24.3

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[57] ABSTRACT

An apparatus for placing at least one biological reagent at a plurality of locations on a substrate includes a stamp member onto which the at least one biological reagent is applied. The stamp member defines a plurality of transfer elements patterned to correspond to the plurality of locations. The stamp member contacts the substrate to transfer the at least one biological reagent from the plurality of transfer elements to the plurality of locations. The transfer elements can be defined by reservoirs or projected portions of the stamp member.

16 Claims, 8 Drawing Sheets

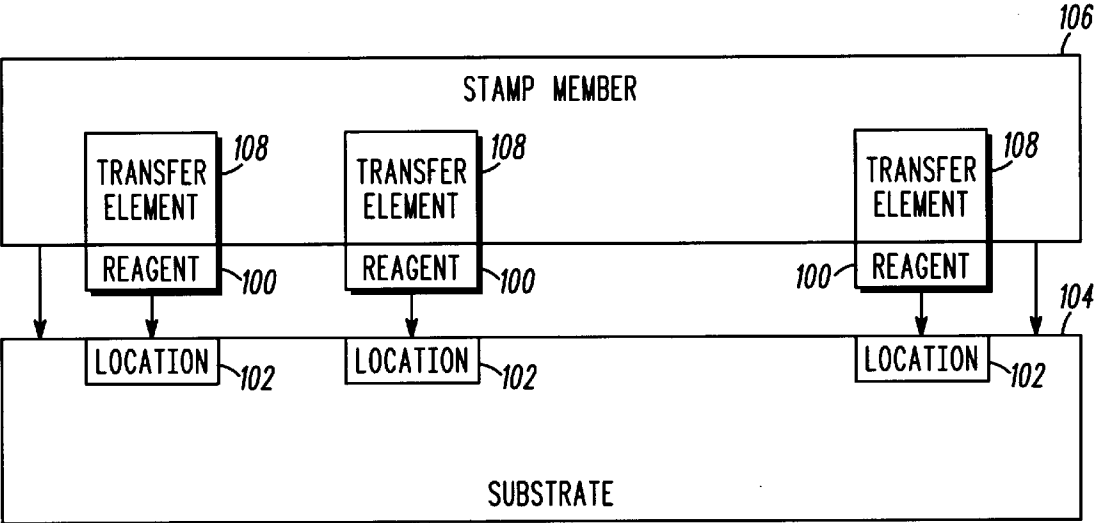


FIG. 1

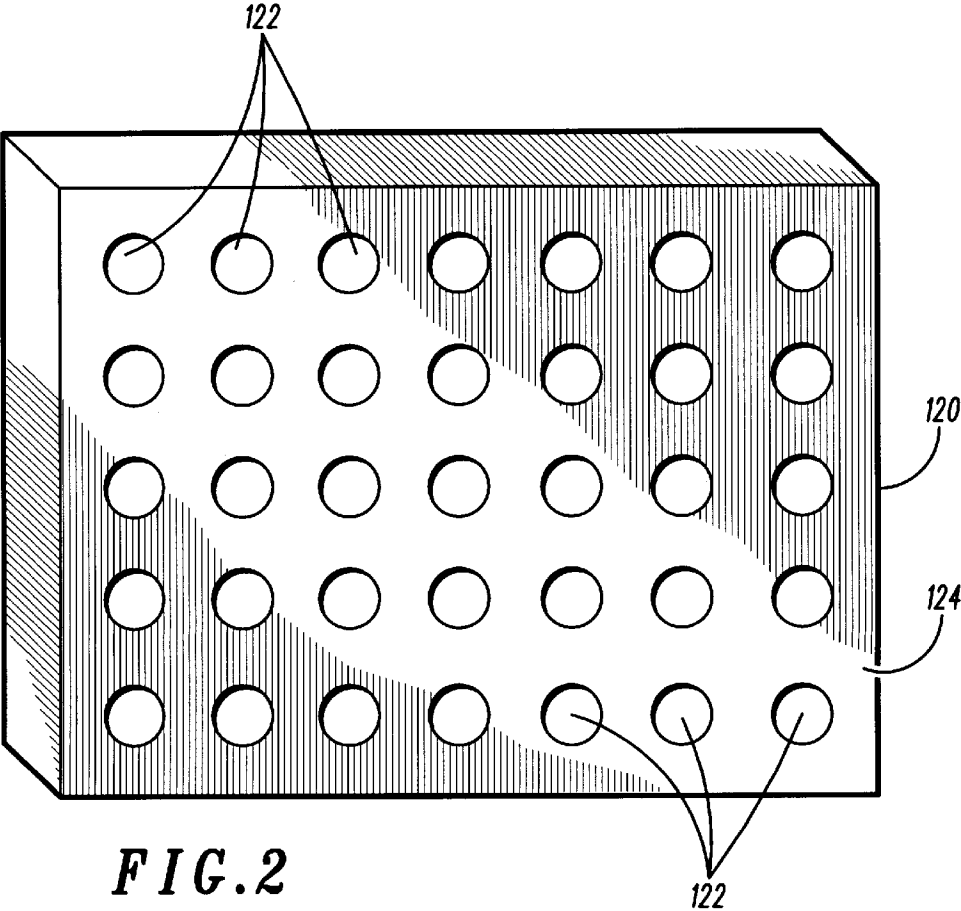


FIG. 2

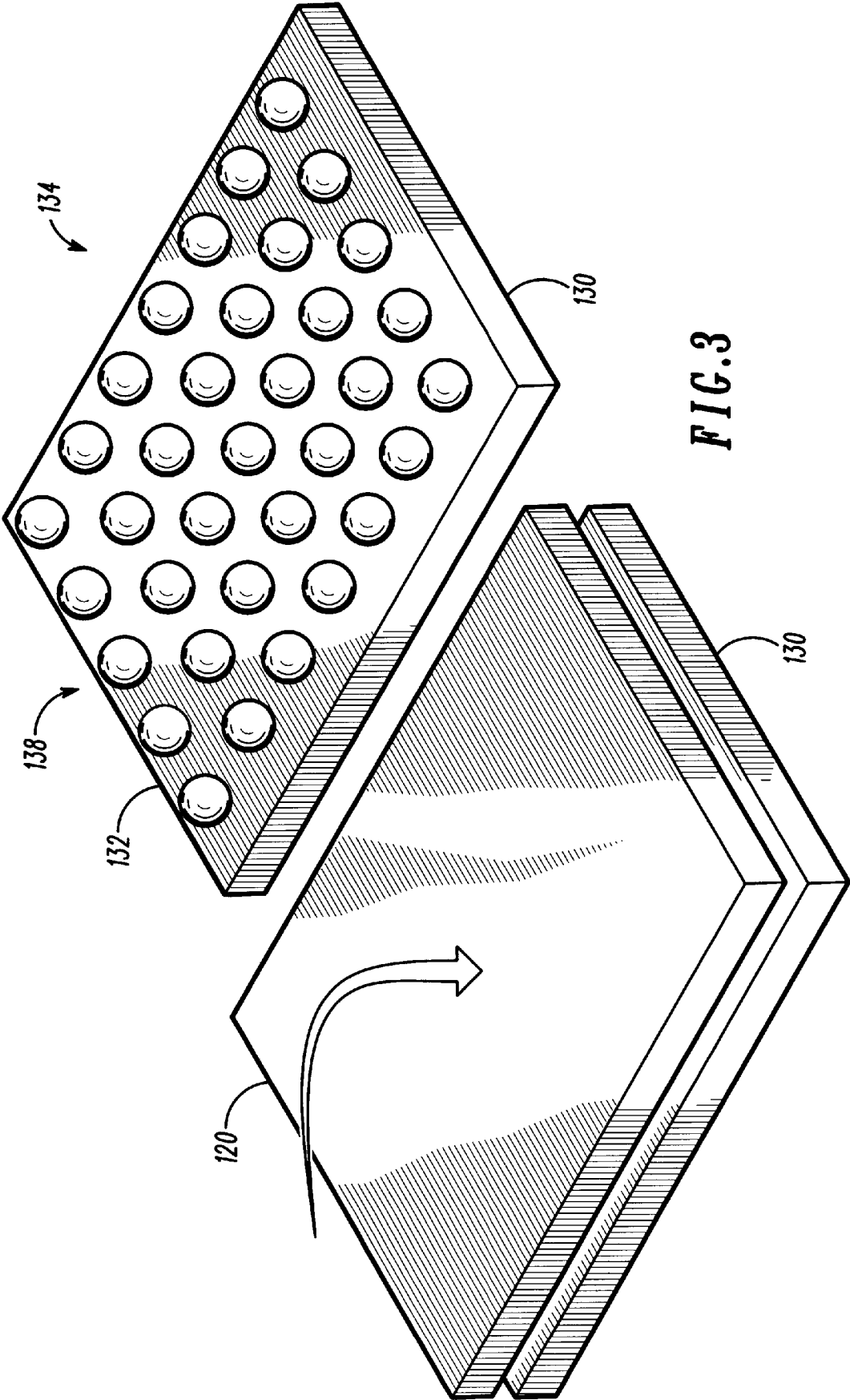


FIG. 4

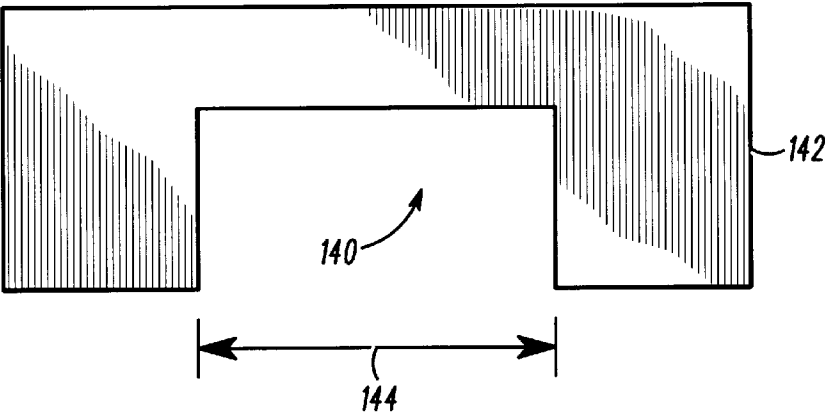


FIG. 5

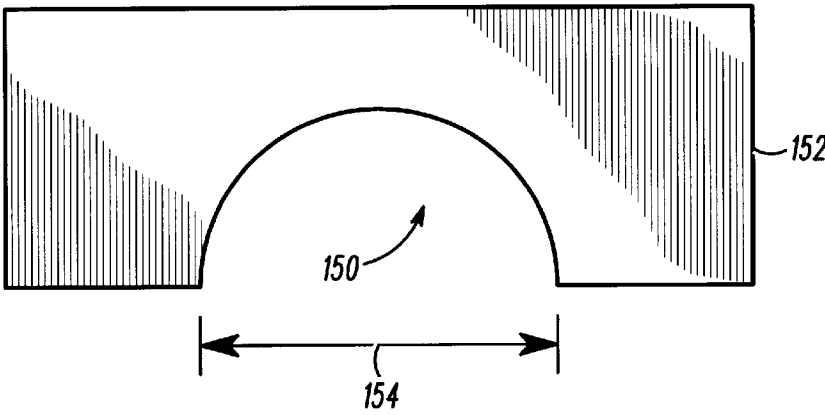
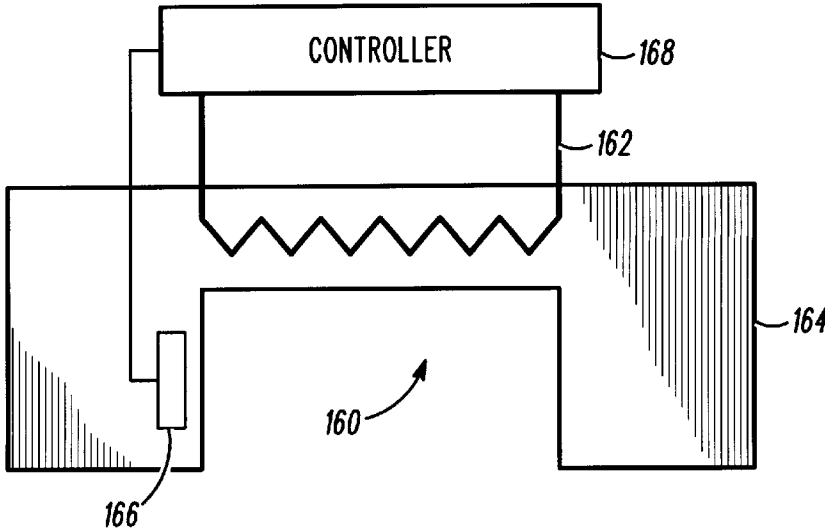
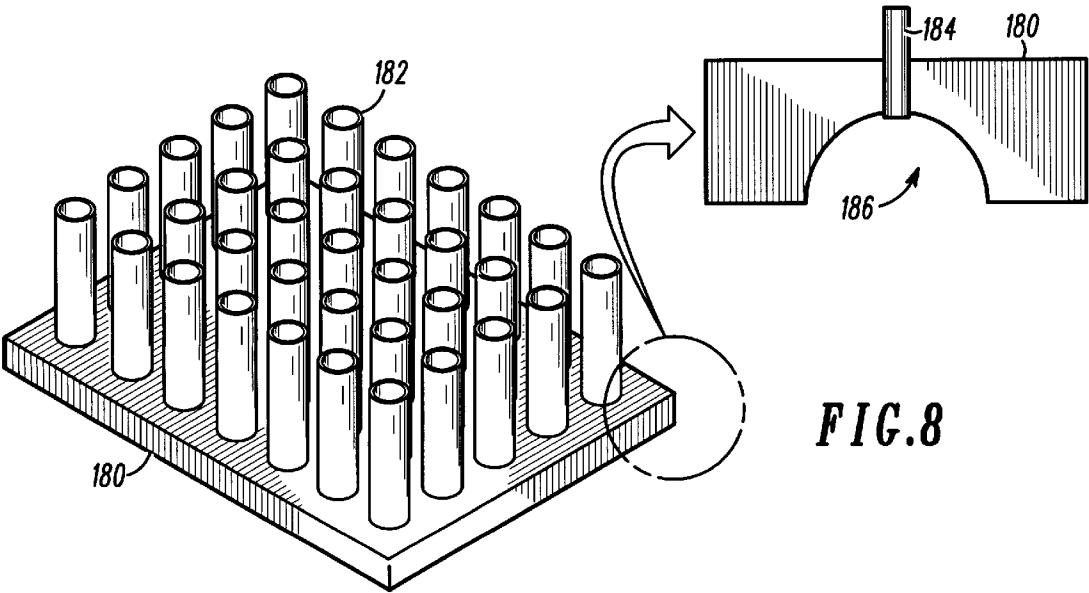
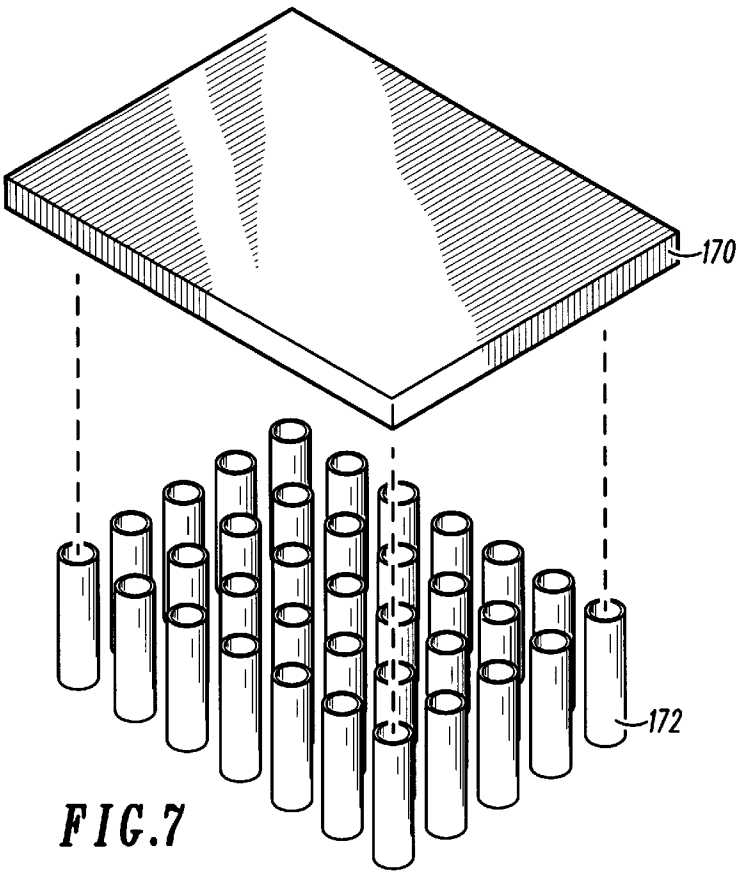


FIG. 6





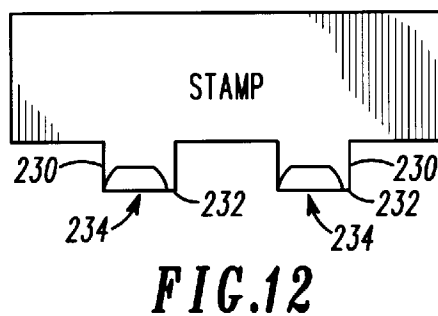
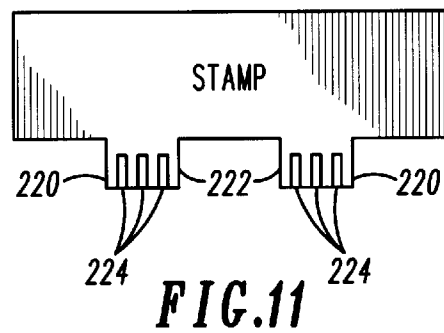
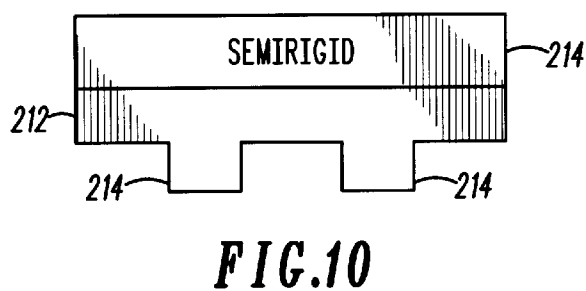
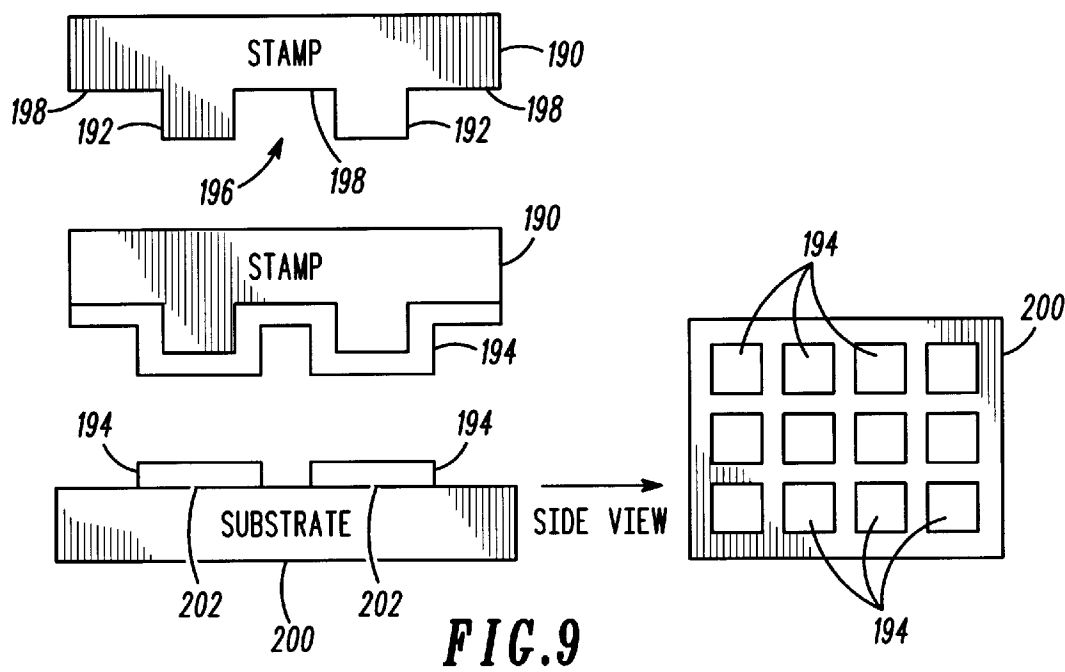


FIG.13

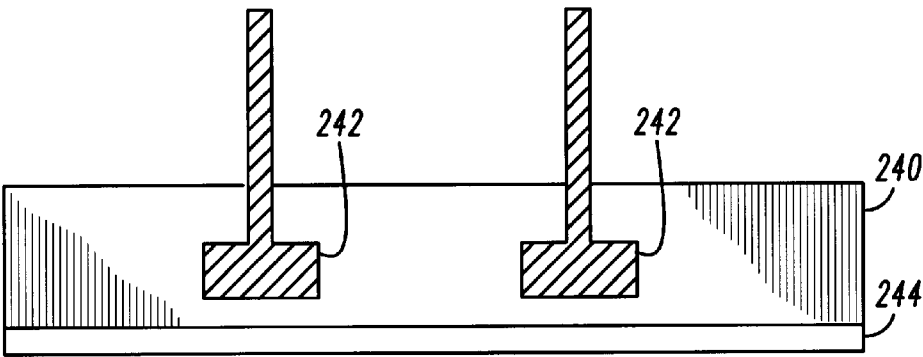


FIG.14

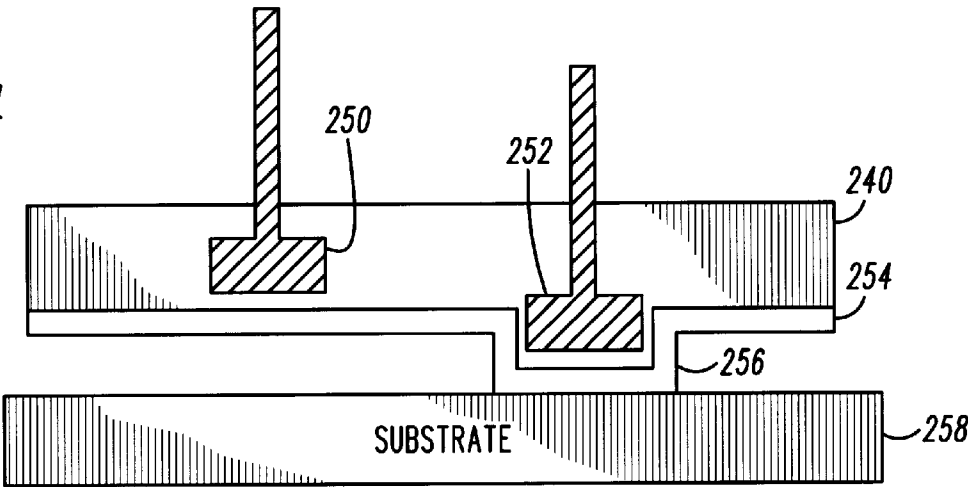
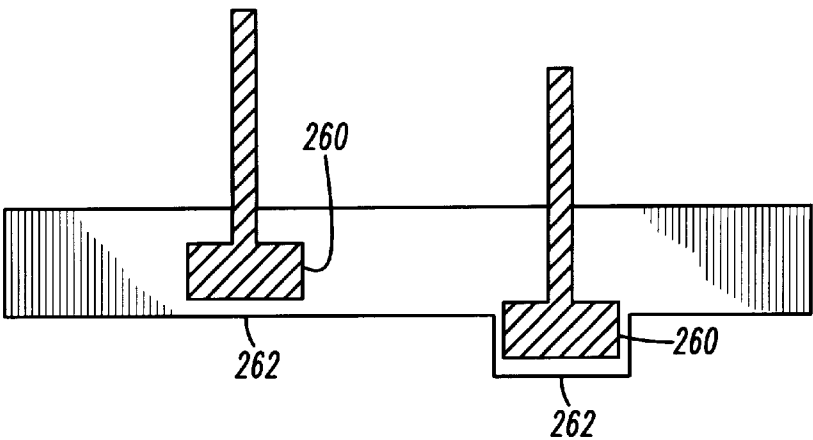
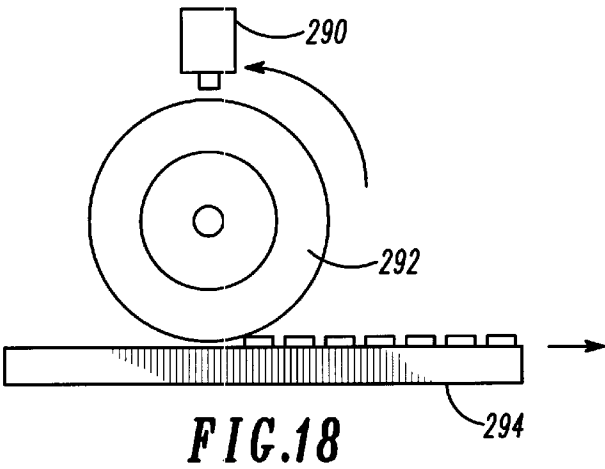
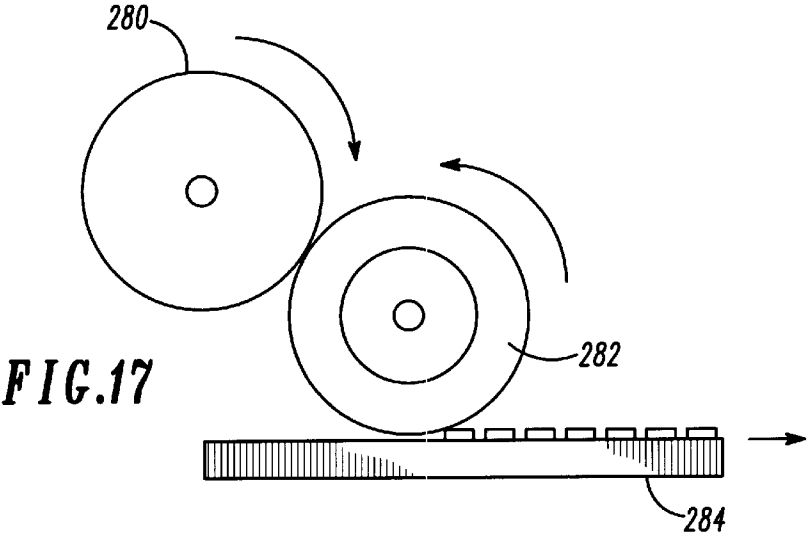
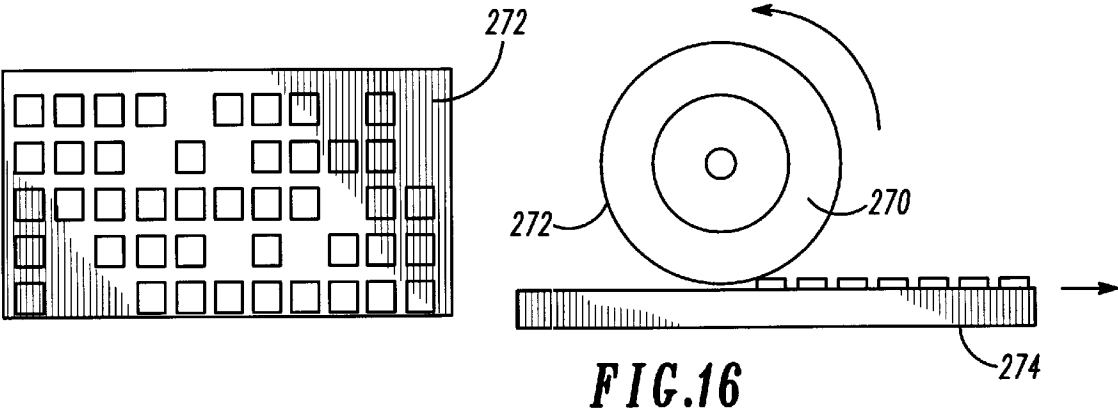
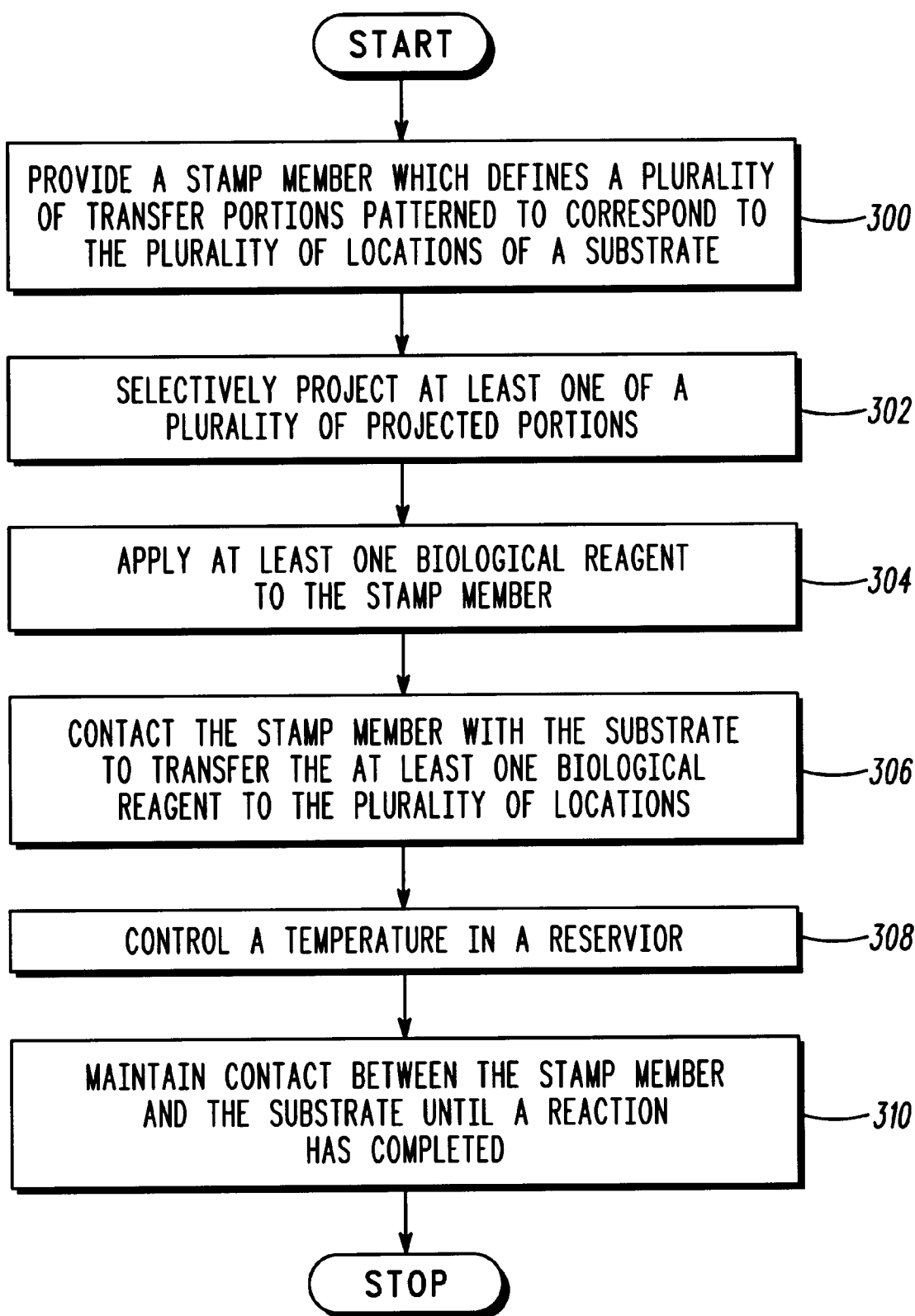


FIG.15





**FIG.19**

## METHODS AND SYSTEMS FOR BIOLOGICAL REAGENT PLACEMENT

This is a continuation of application Ser. No. 08/648,635 filed on May 13, 1996 now U.S. Pat. No. 5,731,157.

### FIELD OF THE INVENTION

The present invention relates to methods and systems for placing biological reagents on a substrate.

### BACKGROUND OF THE INVENTION

Recently, an increased effort has been directed toward the development of chips for molecular detection. In general, a molecular detection chip includes a substrate on which an array of binding sites is arranged. Each binding site (or hybridization site) has a respective molecular receptor which binds or hybridizes with a molecule having a predetermined structure. A sample solution is applied to the molecular detection chip, and molecules in the sample bind or hybridize at one or more of the binding sites. The particular binding sites at which hybridization occurs are detected, and one or more molecular structures within the sample are subsequently deduced.

Of great interest are molecular detection chips for gene sequencing. These chips, often referred to as DNA chips, utilize an array of selective binding sites each having respective single-stranded DNA probes. A sample of single-stranded DNA fragments, referred to as target DNA, is applied to the DNA chip. The DNA fragments attach to one or more of the DNA probes by a hybridization process. By detecting which DNA probes have a DNA fragment hybridized thereto, a sequence of nucleotide bases within the DNA fragment can be determined.

A number of approaches have been devised for putting an array of molecular receptors on a substrate. Affymax has proposed a lithographic technique of synthesizing peptides or nucleic acids on a glass surface. To synthesize an array of n-mer oligonucleotide probes, 4n lithographic write steps are required. This results from the four different constituent nucleotides (adenine, cytosine, guanine, and thymine) which can be located at each of the n nucleotide locations in an n-mer probe. A shortcoming of the lithographic technique is that a new set of lithographic masks must be produced if a new configuration of probes is desired in the array. Further, the use of 4n mask levels results in an undesirably low yield.

Currently, a molecular sample is applied to probes on a molecular detection chip by immersing the chip into a sample solution. This approach requires a relatively large quantity of samples whose quantity is often limited. Further, molecules will often bind erroneously to sites on the molecular detection chip to produce false positive readings.

### BRIEF DESCRIPTION OF THE DRAWINGS

The invention is pointed out with particularity in the appended claims. However, other features of the invention will become more apparent and the invention will be best understood by referring to the following detailed description in conjunction with the accompanying drawings in which:

FIG. 1 is a block diagram of an embodiment of an apparatus for placing at least one biological reagent at a plurality of locations on a substrate;

FIG. 2 is an illustration of an embodiment of a stamp member in accordance with the present invention;

FIG. 3 illustrates at least one biological reagent being transferred to a substrate from the stamp member of FIG. 2;

FIG. 4 is an illustration of a rectangular-shaped reservoir for use as a transfer element;

FIG. 5 is an illustration of a spherical-shaped reservoir for use as a transfer element;

FIG. 6 is an illustration of a means for controlling a temperature in a reservoir;

FIG. 7 is an illustration of another technique to introduce the at least one reagent into the reservoirs;

FIG. 8 is an illustration of an embodiment of a stamp member which provides another technique for applying the at least one reagent into the reservoirs;

FIG. 9 is an illustration of a stamp member having a plurality of projected portions which define a plurality of transfer elements;

FIG. 10 illustrates an embodiment of the stamp member having a support member which supports an absorbent layer;

FIG. 11 illustrates an alternative approach to increasing an absorbency of the stamp member by increasing a surface area of a stamping surface;

FIG. 12 illustrates an embodiment the stamp member which utilizes both projected portions and reservoirs;

FIG. 13 illustrates an embodiment of a stamp member having selectively projectable transfer elements;

FIG. 14 illustrates the stamp member having an unprojected piston and a projected piston;

FIG. 15 illustrates an embodiment of a selectively projectable stamp member having means for temperature control;

FIG. 16 shows an example of a stamp member having a cylindrical shape;

FIG. 17 illustrates a roller used to apply a reagent to a stamp member;

FIG. 18 illustrates at least one dispensing head used to apply a reagent to a stamp member; and

FIG. 19 is a flow chart summarizing steps performed in an embodiment of method of placing at least one biological reagent at a plurality of locations on a substrate.

### DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. 1 is a block diagram of an embodiment of an apparatus for placing at least one biological reagent **100** at a plurality of locations **102** on a substrate **104**. The apparatus includes a stamp member **106** onto which the at least one biological reagent **100** is applied. The stamp member **106** defines a plurality of transfer elements **108** patterned to correspond to the plurality of locations **102**. The at least one biological reagent **100** is transferred from the plurality of transfer elements **108** to the plurality of locations **102** by contacting the stamp member **106** with the substrate **104**.

The at least one biological reagent **100** can include a common biological reagent which is applied to each of the plurality of transfer elements **108**. In this case, the common biological reagent is transferred to all of the plurality of locations **102** on the substrate **104**, and hence, is common to all of the plurality of locations **102**. Alternatively, each of the plurality of transfer elements **108** can receive a respective one of the at least one biological reagent **100**. Here, different biological reagents can be transferred to different locations on the substrate **104**.

It is noted that the at least one biological reagent **100**, in this embodiment and other embodiments described herein, can generally comprise any reagent or chemical. Of particular interest, however, are biological reagents including, but

not limited to, single nucleotides, nucleotide chains such as DNA fragments and RNA fragments, and other nucleic acids.

Embodiments of the present invention can be advantageously utilized for transferring biological reagents to a substrate which forms a molecular detection apparatus, such as a gene sequencing chip or a disease diagnosis chip. The biological reagents can be transferred to form molecular detection probes at binding sites of the molecular detection apparatus. Alternatively, the biological reagents can include target molecules which hybridize with selective ones of the binding sites already having molecular detection probes.

It is also noted that the substrate **104** can be formed of a variety of materials which include, but are not limited to, metals, semiconductors, paper, glass, and plastic, for the various embodiments of the present invention described herein. The substrate **104** can be either flexible or rigid, and can have any shape, including but not limited to a planar shape, a roll shape, and a cylindrical shape.

FIG. **2** is an illustration of an embodiment of a stamp member **120** in accordance with the present invention. The stamp member **120** defines a plurality of transfer elements **122**. The plurality of transfer elements **122** can be patterned as an array, such as the two-dimensional array illustrated in FIG. **2**, to correspond to an array of locations on a substrate. It is noted, however, that alternative patterns of the plurality of transfer elements **122** can be utilized. The stamp member **120** has a face **124** at which the plurality of transfer elements **122** is defined. In this embodiment, the face **124** is substantially planar.

FIG. **3** illustrates at least one biological reagent being transferred to a substrate **130** from the stamp member **120** of FIG. **2**. The face **124** of the stamp member **120** is directed toward a surface **132** of the substrate **130** until contact is made. At contact, either the face **124** contacts the substrate **130**, or at least one of the plurality of transfer elements **122** contacts the substrate **130**. Thereafter, as indicated by reference numeral **134**, the stamp member **120** is removed from the substrate **130**. Here, either the at least one biological reagent or a reaction product thereof remains at a plurality of locations **138** of the substrate **130**.

In the various embodiments of the present invention, the plurality of transfer elements can have any of a variety of forms. In one form, the plurality of transfer elements includes a plurality of reservoirs defined on a surface of the stamp member. The plurality of reservoirs are arranged to correspond to the plurality of locations on the substrate. Each reservoir has the form of a small inclusion in the stamp member for holding small quantities of reagents for chemical reactions. For example, the reservoirs can be utilized to contain on the order of a picoliter of a reagent.

Using conventional aligning techniques for mask/wafer positioning, at least one reagent can be accurately placed at predetermined locations of a chemically-sensitive substrate by contacting the substrate with a stamp member having a corresponding array of reservoirs. While the stamp member is in contact with the substrate, any chemical reactions between the at least one reagent and the chemically-sensitive substrate are contained within the reservoirs. Preferably, the reservoirs have a predetermined shape and a predetermined volume so as not to significantly affect the chemical reaction of interest.

The stamp member is held in contact with the substrate until the chemical reactions have completed. Thereafter, the stamp member is removed from the substrate leaving regions of reaction products on the substrate.

FIG. **4** is an illustration of a rectangular-shaped reservoir **140** for use as a transfer element. The rectangular-shaped reservoir **140** is defined within a portion of a stamp member **142**. In one embodiment, the rectangular-shaped reservoir **140** has a dimension **144** greater than  $10\ \mu\text{m}$  so as not to affect a predetermined chemical reaction performed therein.

FIG. **5** is an illustration of a spherical-shaped reservoir **150** for use as a transfer element. The spherical-shaped reservoir **150** is defined within a portion of a stamp member **152**. Similar to the rectangular-shaped reservoir **140**, the spherical-shaped reservoir **150** can have a diameter **154** greater than  $10\ \mu\text{m}$  so as not to affect a predetermined chemical reaction performed therein.

FIG. **6** is an illustration of a means for controlling a temperature in a reservoir **160**. A heating element **162** is embedded in a stamp member **164** proximate to the reservoir **160**. The heating element **162** can be a resistive heating element, for example, which heats the reservoir **160** in dependence upon a current applied therethrough.

A temperature probe **166** is embedded in the stamp member **164** proximate to the reservoir **160**. The temperature probe **166** measures the temperature of the reservoir **160** or of a reagent in the reservoir **160**. A signal representative of the temperature is communicated from the temperature probe **166** to a controller **168**. The controller **168** processes the signal to form a control signal which is applied to the heating element **162**. The control signal is formed in order to control the temperature to a desired level.

By embedding a heating element and a temperature probe in each of a plurality of reservoirs, the temperature at each reservoir can be locally controlled. This is useful for controlling hybridization of genetic material onto specific substrate locations for diagnostic purposes.

Temperature control at a reservoir is also beneficial for providing a means for amplifying a biological sample contained therein. Here, the temperature can be controlled to provide the heating steps in a PCR (polymerase chain reaction) amplification technique.

For the various embodiments of the present invention described herein, the at least one biological reagent can be introduced into the reservoirs by a number of different techniques. One technique is to provide a substantially uniform wetting of the stamp member. Here, the stamp member can be immersed in a fluid containing the at least one reagent to fill each of the reservoirs. Alternatively, the face of the stamp member can be rolled on or contacted with a saturated absorbent material containing the at least one reagent. In both of these cases, the same at least one reagent is typically applied to all of the reservoirs.

FIG. **7** is an illustration of another technique to introduce the at least one reagent into the reservoirs. Here, the at least one reagent is directly placed into a plurality of reservoirs of a stamp member **170** using a corresponding plurality of capillaries **172** (or a corresponding plurality of micropipets). As illustrated, the at least one reagent can be applied to the reservoirs from the bottom of the stamp member **170**.

FIG. **8** is an illustration of an embodiment of a stamp member **180** which provides another technique for applying the at least one reagent into the reservoirs. A plurality of capillaries **182** or other like tube members is embedded in the stamp member **180**. A capillary **184** of the plurality of capillaries **182** is illustrated in more detail. The capillary **184** is embedded in the stamp member **180** proximate to a reservoir **186**. The capillary **184** provides fluidic communication to the reservoir **186**. Using this embodiment, a respective biological reagent can be applied to each of the

plurality of reservoirs by a respective one of the plurality of capillaries **182**.

The direct placement approaches illustrated in FIGS. **7** and **8** are advantageous over the uniform wetting approaches with respect to both reagent quantity and placement. Specifically, a reduced amount of reagent is needed to fill the reservoirs using direct placement. Further, different reagents can be applied to different reservoirs for placement at different locations on the substrate.

As described earlier, the plurality of transfer elements in accordance with the present invention can have any of a variety of forms. A second form for the transfer elements is illustrated in FIG. **9**.

FIG. **9** is an illustration of a stamp member **190** having a plurality of projected portions **192** which define a plurality of transfer elements. The plurality of projected portions **192** are patterned to correspond to a plurality of locations on a substrate at which one or more reagents are to be placed.

The plurality of projected portions **192** absorb at least one biological reagent **194** which is applied to a face **196** of the stamp member **190**. As illustrated, the at least one biological reagent **194** can also be absorbed by non-projected portions **198** of the stamp member **190**. This can occur if the at least one biological reagent **194** is applied using a uniform wetting technique as described earlier.

The stamp member **190** is contacted with a substrate **200** to transfer the at least one biological reagent **194** to a plurality of locations **202**. At contact, a stamping surface **204** of each of the plurality of projected portions **192** is in contact with the substrate **200** at a respective one of the plurality of locations **202**. However, the non-projected portions **198** do not contact the substrate **200**. Upon removing the stamp member **190** from the substrate **200**, the at least one biological reagent **194** remains at the plurality of locations **202** on the substrate **200**.

The stamp member **190** can take the form of a patterned rigid or semi-rigid plate fabricated from materials which include, but are not limited to, glass, elastomer, metal, sol-gels, plastic, and polymers. One or more of these materials can be combined in the stamp member **190** to obtain a flexibility, rigidity, opacity, thermal conductivity, and/or chemical absorbency which is desired.

FIG. **10** illustrates an embodiment of the stamp member **190** having a support member **210** which supports an absorbent layer **212**. The support member **210** is formed of a rigid or semi-rigid material, such as those aforementioned. The absorbent layer **212** is comprised of an absorbent material such as a sol-gel. The absorbent layer **212** defines a plurality of projected portions **214** patterned to correspond to a plurality of locations on a substrate.

FIG. **11** illustrates an alternative approach to increasing an absorbency of the stamp member **190** by increasing a surface area of a stamping surface. The stamp member **190** defines a plurality of projected portions **220**. Each of the plurality of projected portions **220** has a stamping surface **222** which defines at least one cavity **224**. The at least one cavity **224** increases the absorbency of each of the plurality of projected portions **220** by increasing a surface area of the stamping surface **222**. The at least one cavity **224** can be defined by a series of ridges at each of the plurality of projected portions **220**.

FIG. **12** illustrates an embodiment the stamp member **190** which utilizes both projected portions and reservoirs. Here, each of a plurality of projected portions **230** has a stamping surface **232** which defines a reservoir **234**. Each reservoir **234** is formed in accordance with any of the reservoir embodiments described herein.

As a result, each reservoir **234** can contain an accurately controlled amount of reagent which is to be transferred to a substrate. Further, a capillary can be embedded in the stamp member **190** to apply a biological reagent to the reservoir **234** of at least one of the plurality of projected portions **230**. Also, a heating element and a temperature probe can be embedded in the stamp member **190** proximate to the reservoir **234** to provide temperature control means for at least one of the projected portions **230**. The temperature control means can be utilized to provide a means for amplifying a biological sample within the reservoir **234** of at least one of the plurality of projected portions **230**.

The projected portions in the above-described embodiments of stamp members can be either fixed or selectively projected. Various means for selectively projecting at least one of the plurality of projected portions can be utilized to allow a single stamp member to be reconfigured for a different pattern of locations on a substrate.

FIG. **13** illustrates an embodiment of a stamp member **240** having selectively projectable transfer elements. A plurality of pistons **242** or other like translational mechanisms are included in the stamp member **240**. Each of the plurality of pistons **242** is independently projectable to form a respective projected portion. Preferably, each of the plurality of pistons **242** is electromechanically projectable. As a result, a pattern of transfer elements for the stamp member **240** is electronically programmable based upon a plurality of electrical signals.

Selected ones of the plurality of pistons **242** are projected to form a pattern of transfer elements. An absorbent layer **244** is deformed by the selected pistons which are projected. The absorbent layer **244** is utilized to receive a biological reagent for transfer to a substrate. This approach can be utilized for defining patterns having dimensions of hundreds of microns, including dimensions as small as 100  $\mu\text{m}$  and below. The use of selectively projectable transfer elements is advantageous in reducing a number of stamps required for a multilevel process.

FIG. **14** illustrates the stamp member **240** having an unprojected piston **250** and a projected piston **252**. The projected piston **252** deforms an absorbent layer **254** to form a projected portion **256**. The projected portion **256** causes a biological reagent to be transferred to a corresponding location on a substrate **258** which contacts the stamp member **240**.

FIG. **15** illustrates an embodiment of a selectively projectable stamp member having means for temperature control. Here, each of a plurality of pistons **260** has a heating element **262** mounted thereto. Optionally, a temperature probe (not specifically illustrated) can also be mounted to each of the plurality of pistons **260**. The heating element **262** allows the temperature of each of the projected portions to be controlled for purposes described earlier.

In various embodiments of the present invention, the stamp member can have various shapes including, but not limited to, a planar shape, a cylindrical shape, a spherical shape, and other curved shapes. The cylindrical shape is advantageous in that the stamp member can be rolled onto the substrate to transfer the at least one biological reagent from the plurality of transfer elements to the plurality of locations.

FIG. **16** shows an example of a stamp member **270** having a cylindrical shape. An outer circumferential surface **272** of the stamp member **270** defines a plurality of transfer elements patterned to correspond to a plurality of locations on a substrate **274**. Rolling the stamp member **270** onto the

substrate **274** causes a continuous pattern of a reagent to be transferred thereto.

FIG. **17** illustrates a roller **280** used to apply a reagent to a stamp member **282**. The roller **280** is well-suited for applying a single type of reagent to all of the plurality of transfer elements on the stamp member **282**. Use of the roller **280** is also advantageous to simultaneously apply the reagent to a portion of the stamp member **282** while another portion of the stamp member **282** is transferring the reagent to a substrate **284**. Although the stamp member **282** is illustrated to have a cylindrical shape, it is noted that a roller can be utilized to apply a reagent to stamp members having a planar shape or another shape.

FIG. **18** illustrates at least one dispensing head **290** used to apply a reagent to a stamp member **292**. The at least one dispensing head **290** applies a specific amount of the reagent directly to the plurality of transfer elements on the stamp member **292**. The at least one dispensing head **290** is well-suited for applying different reagents to different transfer elements on the stamp member **292**. As with the roller **280**, the use of the at least one dispensing head **290** is advantageous to simultaneously apply the reagent to a portion of the stamp member **292** while another portion of the stamp member **292** is transferring the reagent to a substrate **294**.

In a preferred embodiment, the at least one dispensing head **290** is included within a plurality of dispensing bars as described in the copending application entitled "Method and System for Synthesizing Oligonucleotides using Nucleotide-Specific Dispensing Bars", now U.S. Pat. No. 5,733,509 which is incorporated by reference into the disclosure of the present invention. Each of the plurality of dispensing bars is dedicated to dispensing a respective type of reagent. For example, each of four dispensing bars can be dedicated for applying a respective one type of four nucleotide types. Each of the plurality of dispensing bars has a plurality of individually addressable dispensing heads to dispense a reagent in any of a row of transfer elements on the stamp member **292**.

FIG. **19** is a flow chart summarizing steps performed in an embodiment of method of placing at least one biological reagent at a plurality of locations on a substrate. As indicated by block **300**, the method includes a step of providing a stamp member which defines a plurality of transfer elements patterned to correspond to the plurality of locations. Preferably, the stamp member is provided in accordance with those described herein, although alternative embodiments of the method are not limited thereto.

If the plurality of transfer elements have the form of a plurality of projected portions of the stamp member, an optional step of selectively projecting at least one of the plurality of projected portions can be performed, as indicated by block **302**. Each of the at least one of the plurality of projected portions can be electromechanically projected by a respective piston in the stamp member as described earlier. However, other means for selective projecting the at least one of the plurality of projected portions can also be utilized.

As indicated by block **304**, a step of applying the at least one biological reagent to the stamp member is performed. For a transfer element which includes a reservoir, this step can include applying a biological reagent to the reservoir by a capillary embedded in the stamp member. For a plurality of reservoirs, this step can include applying a respective biological reagent to each of the plurality of reservoirs by a respective one of a plurality of capillaries embedded in the stamp member.

As indicated by block **306**, a step of contacting the stamp member with the substrate is performed to transfer the at least one biological reagent from the plurality of transfer elements to the plurality of locations. As described earlier, the step of contacting the stamp member with the substrate can include either stamping or rolling the stamp member onto the substrate.

As indicated by block **308**, an optional step of controlling a temperature in a reservoir can be performed. This step can include applying a signal to a heating element in the stamp member proximate to the reservoir. The temperature can be controlled in this step to control a reaction which occurs in the reservoir.

As indicated by block **310**, a step of maintaining contact between the stamp member and the substrate can be performed until a reaction involving the at least one biological reagent has completed. Thereafter, the stamp member is removed from the substrate.

As described earlier, this method is particularly advantageous where the at least one biological reagent includes at least one nucleotide, and where the plurality of locations are binding sites in a molecular detection apparatus.

Thus, there has been described herein a concept, as well as several embodiments including preferred embodiments of methods and systems for biological reagent placement.

Because the various embodiments of the present invention utilize a stamp member which transfers a reagent by contacting a substrate, they provide a significant improvement in that photolithographic patterning is not required to define chemically active areas on the substrate. This can increase yield of a multilevel fabrication process by reducing a number of steps involved. Further, the stamping process is scalable to large areas and compatible with high-throughput manufacturing requirements.

The use of reservoirs as transfer elements reduces an amount of reagent needed in comparison to immersing the entire substrate into a solution. The use of selectively projectable pistons to define the transfer elements is advantageous in that the stamp member can be reconfigured in real-time.

Additionally, the various embodiments of the present invention as herein-described allow chemical reactions, including hybridization, to be accurately controlled by including providing temperature control at each of the transfer elements. This reduces a requirement of uniform temperature across an entire substrate.

Further, the various embodiments of the present invention allow different samples to be placed only at predetermined regions on a substrate, such as a molecular detection chip. Limiting sample placement can reduce a likelihood of false-positive hybridization (or partial hybridization) in comparison to applying a sample to all of a plurality of combinatorial sites on a molecular detection chip.

It will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than the preferred form specifically set out and described above.

Accordingly, it is intended by the appended claims to cover all modifications of the invention which fall within the true spirit and scope of the invention.

What is claimed is:

1. An apparatus for transferring at least one biological reagent to a substrate, the apparatus comprising:

a stamp member having a plurality of independently projectable portions; and

an applicator to apply the at least one biological reagent to at least one of the independently projectable portions after the at least one of the independently projectable portions has been selectively projected;

wherein the at least one of the independently projectable portions is for contacting with the substrate to transfer the at least one biological reagent to the substrate. 5

2. The apparatus of claim 1 wherein the plurality of independently projectable portions includes a first independently projectable portion and a second independently projectable portion. 10

3. The apparatus of claim 2 wherein the first independently projectable portion is projected and the second independently projectable portion is unprojected.

4. The apparatus of claim 2 wherein the stamp member includes a first electromechanical element associated with the first independently projectable portion and a second electromechanical element associated with the second independently projectable portion. 15

5. The apparatus of claim 4 wherein the first electromechanical element includes a first piston and wherein the second electromechanical element includes a second piston. 20

6. The apparatus of claim 2 further comprising a first temperature probe associated with the first independently projectable portion and a second temperature probe associated with the second independently projectable portion. 25

7. The apparatus of claim 2 further comprising a first heating element associated with the first independently projectable portion and a second heating element associated with the second independently projectable portion. 30

8. The apparatus of claim 1 wherein the applicator includes a roller.

9. The apparatus of claim 1 wherein the applicator includes at least one dispensing head.

10. The apparatus of claim 1 wherein the applicator comprises a capillary embedded in the stamp member. 35

11. A method of transferring at least one biological reagent to a substrate, the method comprising the steps of: providing a stamp member having a plurality of independently projectable portions including a first projectable portion and a second projectable portion;

selectively projecting the first projectable portion;

applying the at least one biological reagent to the first projectable portion after selectively projecting the first projectable portion; and

contacting the stamp member with the substrate while the second projectable portion is unprojected to transfer the at least one biological reagent from the stamp member to the substrate.

12. The method of claim 11 wherein the first projectable portion is projected in response to at least one electrical signal. 15

13. The method of claim 11 wherein the stamp member includes a first electromechanical element associated with the first independently projectable portion and a second electromechanical element associated with the second independently projectable portion. 20

14. The method of claim 13 wherein the first electromechanical element includes a first piston and wherein the second electromechanical element includes a second piston.

15. The method of claim 11 further comprising:

providing a first temperature probe associated with the first independently projectable portion; and

providing a second temperature probe associated with the second independently projectable portion.

16. The method of claim 11 further comprising:

providing a first heating element associated with the first independently projectable portion; and

providing a second heating element associated with the second independently projectable portion.

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